

Enabling Renewables with Energy Storage



**Energy Systems Integration Facility Workshop
October 27, 2011**

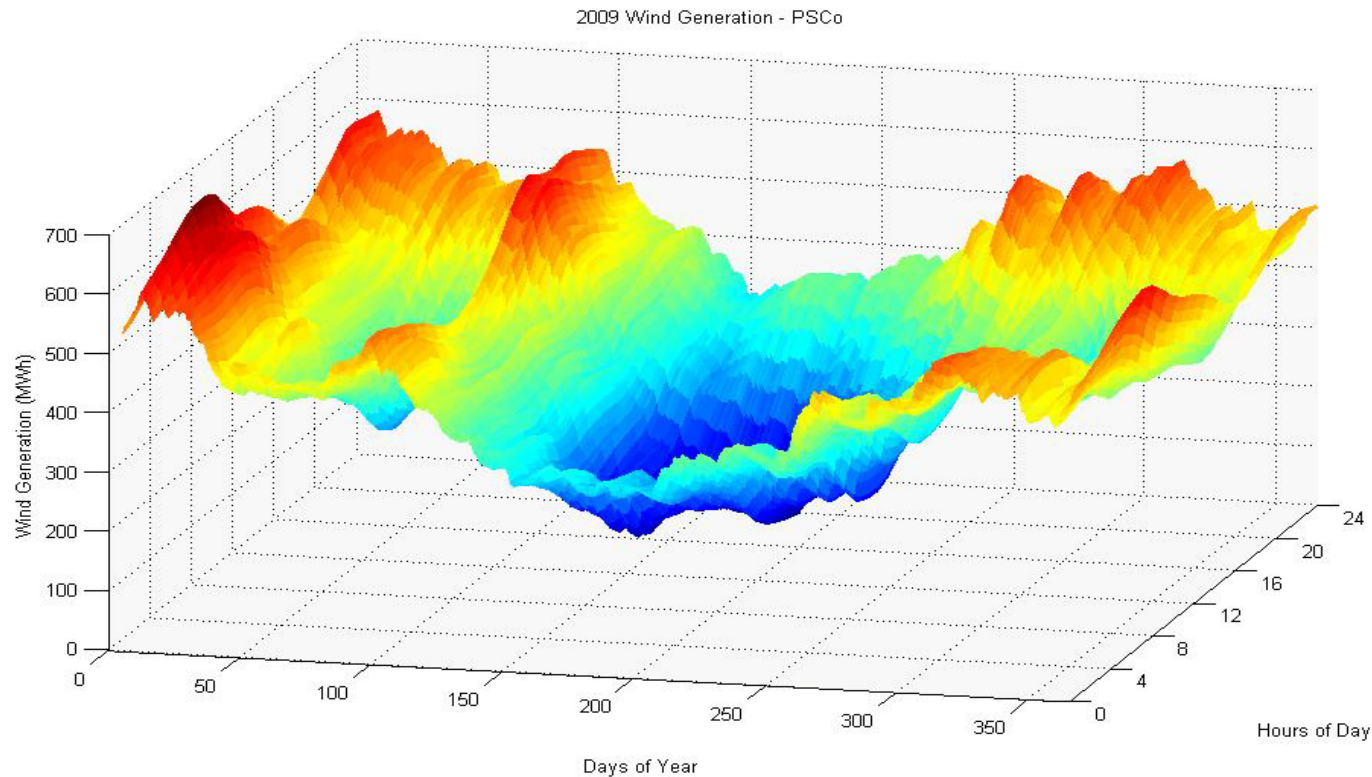
Frank Novachek

Energy Storage at Xcel Energy

- **Storage is a means to provide more system control, supporting:**
 - Generation – Shifting wind output to minimize impact of renewables variability; reduced wear and tear on conventional generators
 - Transmission – Ancillary services
 - Distribution – Voltage regulation and peak shaving
 - Individual customers – Power quality & peak shaving
- **Strategic to Xcel Energy because of the high wind and solar PV penetrations expected on our operating systems**

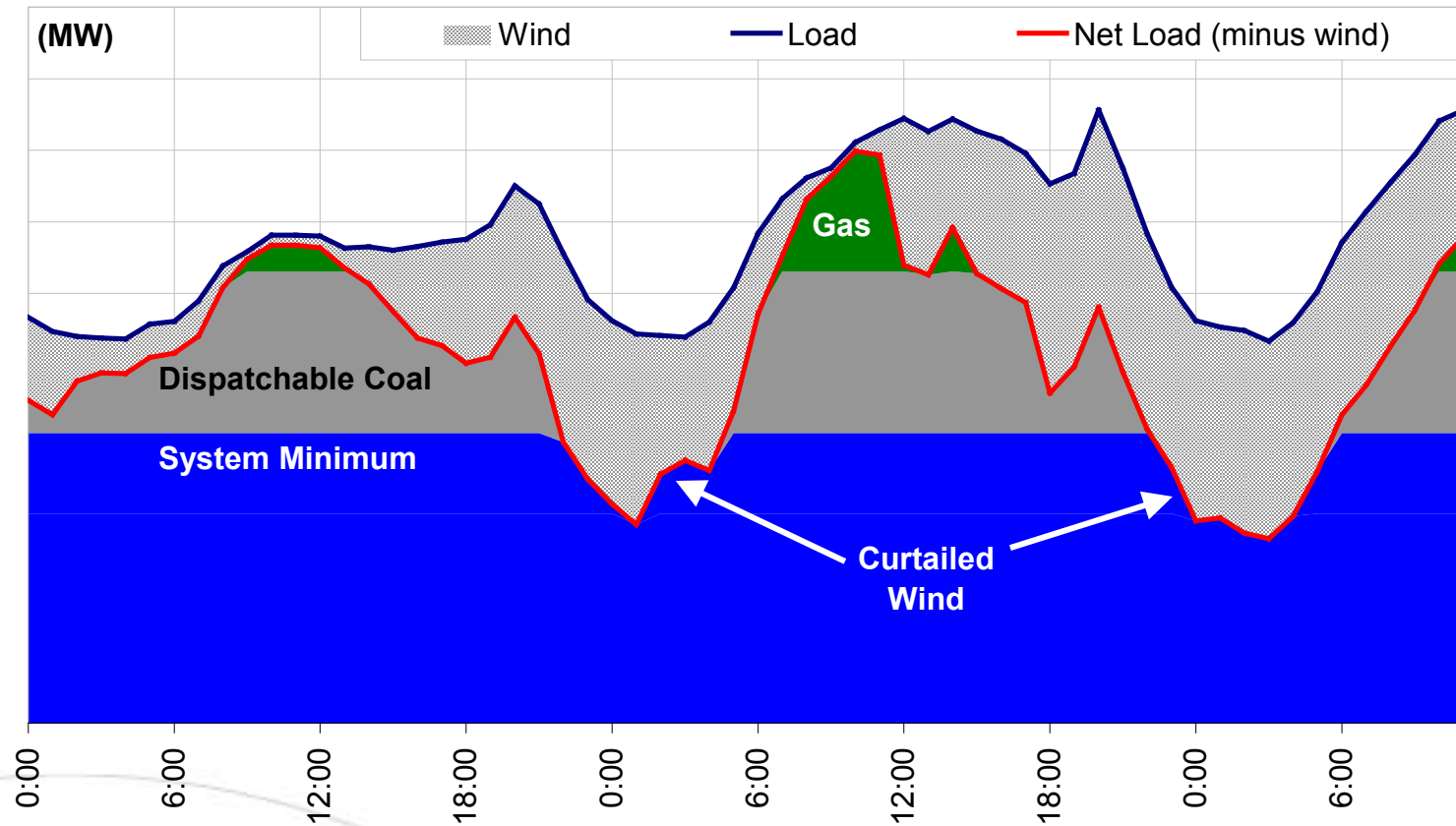
Wind Doesn't Always Blow When Needed

Actual 2009 Wind Generation in Colorado



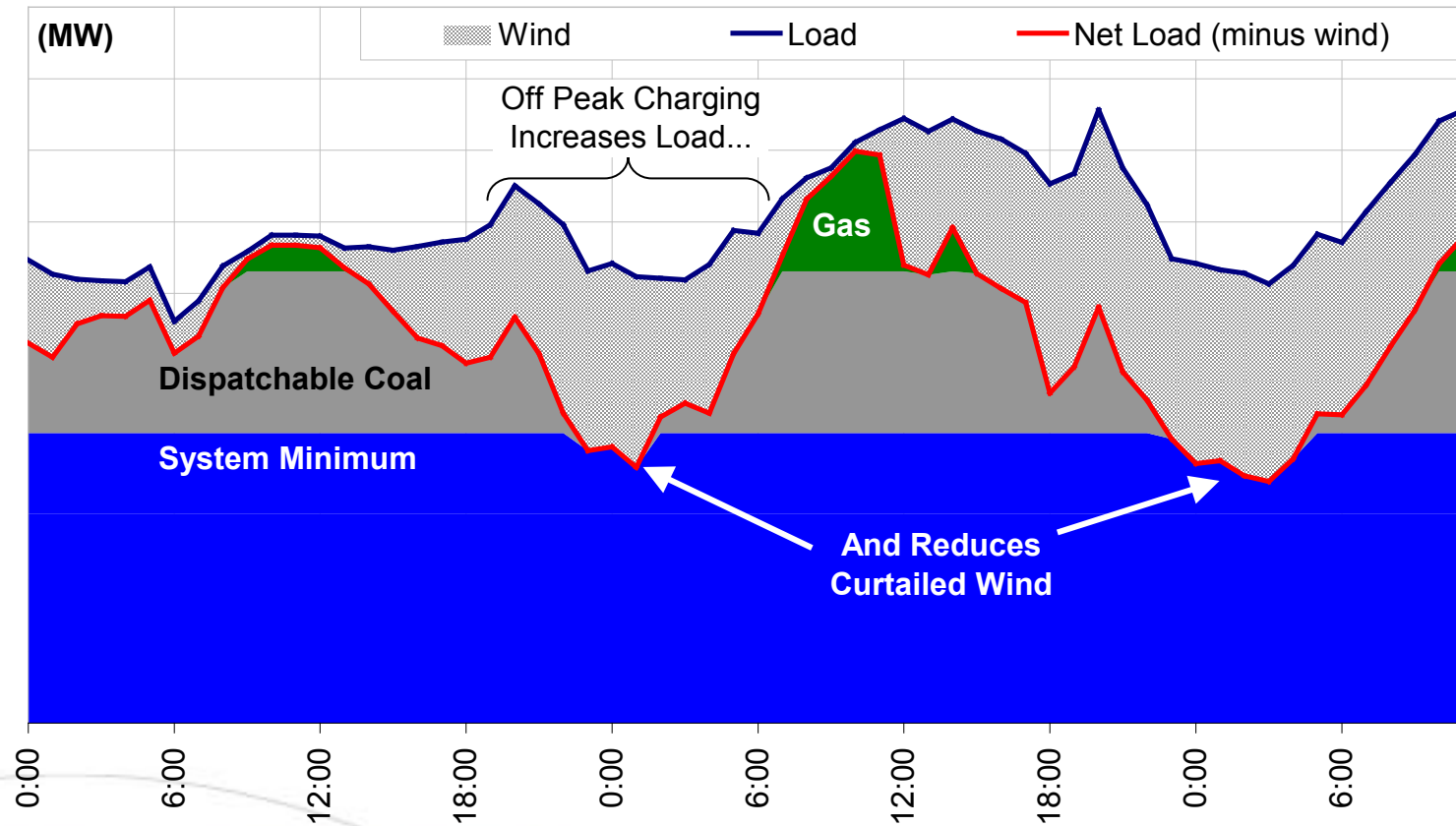
System Bottoming Effects (No Storage)

System with Coal Baseload



System Bottoming Effects (With Storage)

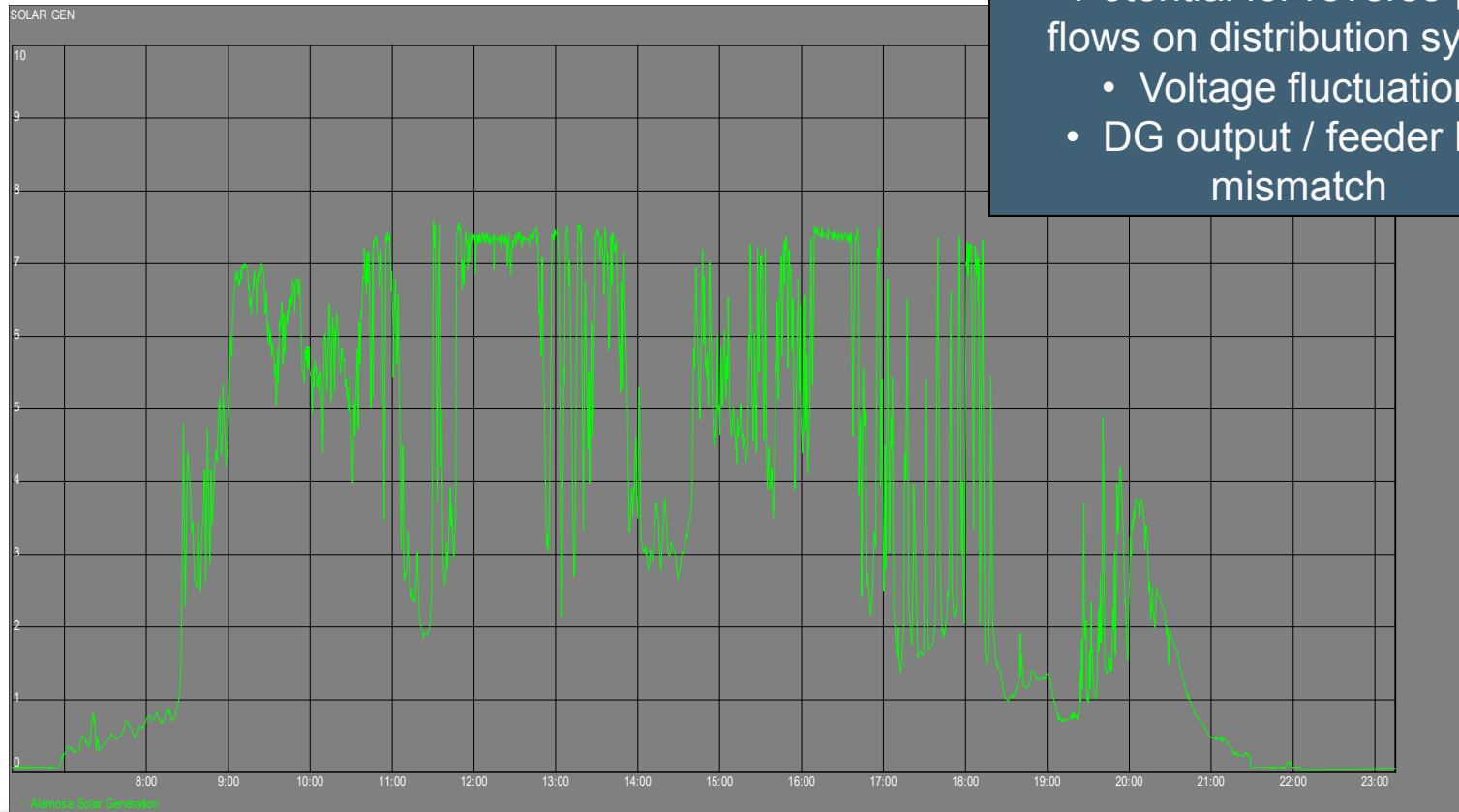
System with Coal Baseload



Solar PV Production

Grid Issues Related to High Penetrations of Solar PV:

- Potential for reverse power flows on distribution system
 - Voltage fluctuations
 - DG output / feeder load mismatch

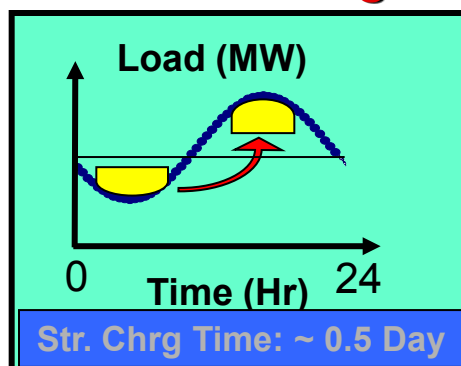


Data from PSCo 8 MW Solar PV Facility in Alamosa, CO

Renewables Integration

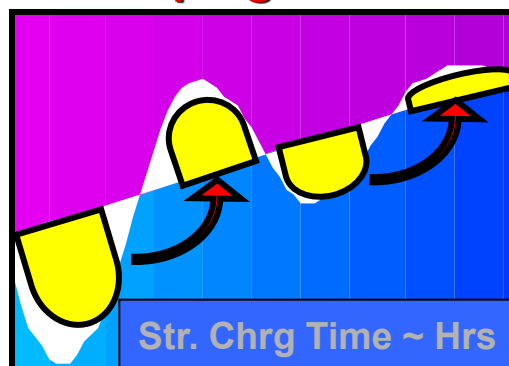
Value Elements for Energy Storage

Time Shifting



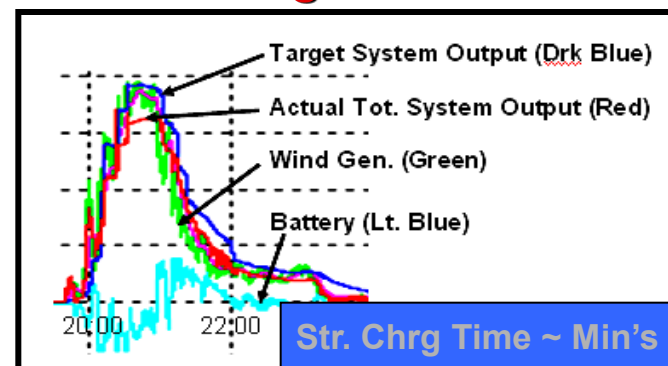
- Arbitrage
- Constraint Relief
- Curtailment Avoidance
- Load/DG Matching
- Peak Shaving

Ramping Control



- Reduced generator cycling
- Reduced reserve requirements (gas & elect)
- Power flow control (distribution)
- Voltage stability (distribution)

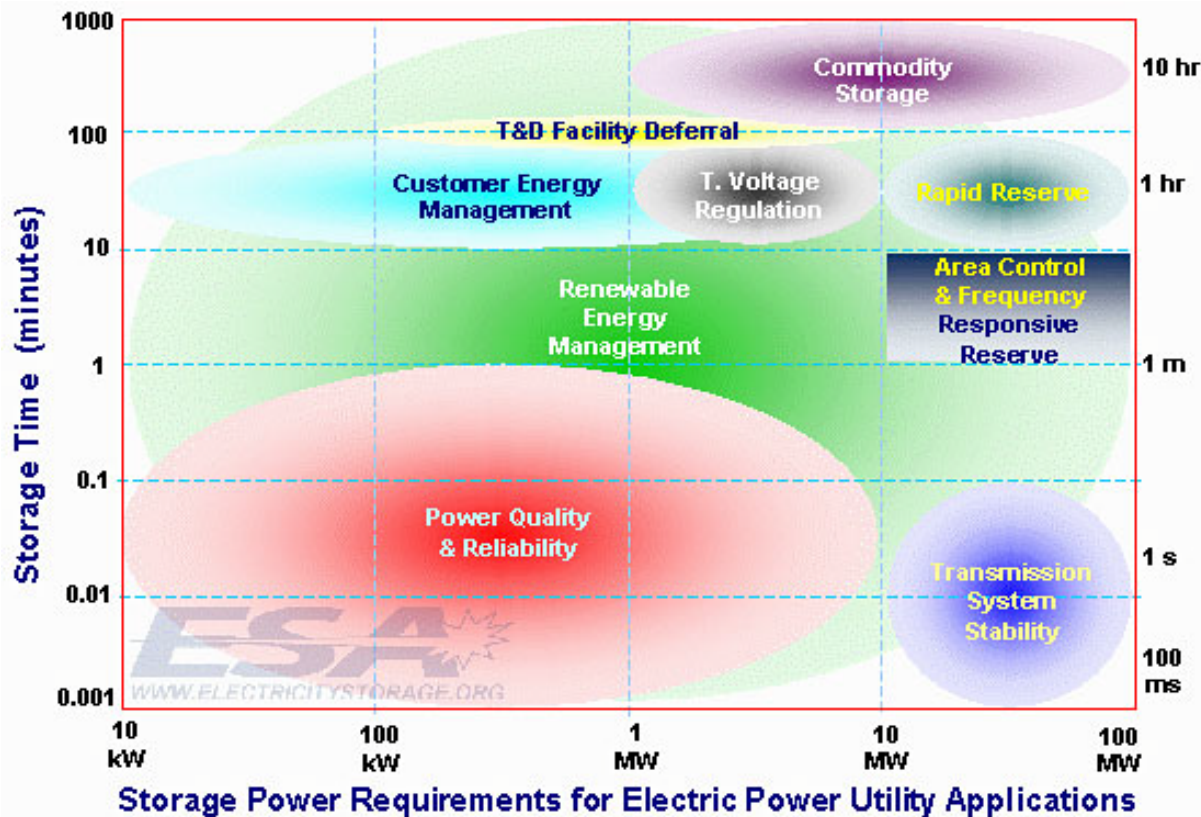
Regulation



- Frequency – “Reg Up/Reg Down”
- Voltage/VAR support
- Fast response to system perturbations

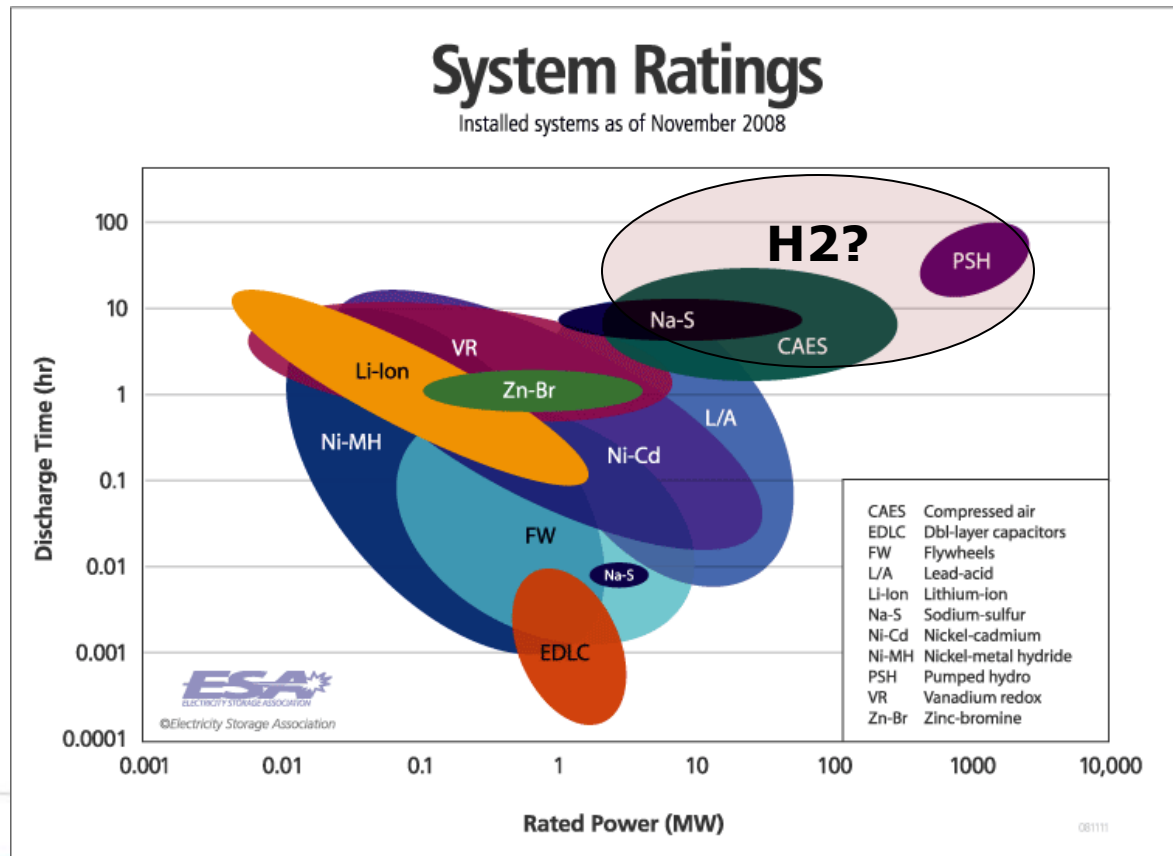
Source: EPRI

Utility Applications for Storage



Data from Sandia Report 2002-1314

Storage Ratings By Technology



Storage Expensive Now

... But There's Promise

- System does not currently have much wind curtailment exposure that could be cured by energy storage, but higher penetrations could
- Current competition for bulk energy storage is a device that is between a CT and a CCGT (4-6 Hrs of on peak use per day)
- Commercially available storage technologies have a higher capital cost today than those alternatives – But some have potential
- Storage has the potential to provide additional difficult to value services
 - Both load and a generation source providing operational flexibility
 - Quick response – though value is system dependent
 - Smaller, distributed systems could serve multiple functions (case specific) to facilitate both wind and solar PV integration with the same assets

Xcel Energy R&D Interests

– Renewables Integration

- ▶ **Utility Energy Supply & Storage**
 - ▶ Bulk Energy Storage
 - ▶ Fast Response Gas Resources
- ▶ **Distributed Energy Supply & Storage**
 - ▶ Batteries
 - ▶ Fuel Cells
 - ▶ Demand Response Resources
- ▶ **Grid Optimization & Automation**
 - ▶ Advanced Inverters
 - ▶ Grid Communications and Coordination

The Potential For the ESIF

- ▶ **Help Identify Optimal Utility Solutions Before Major Capital Investments Are Made**
 - ▶ Predictive Modeling & Simulation
 - ▶ Technology Demonstrations
 - ▶ Combined-Solution Optimizations
- ▶ **Potential for Distribution Test Feeder at SolarTAC**
 - ▶ Validate ESIF Modeling & Simulation
 - ▶ Stress Test Solutions Under Actual Feeder Conditions w/o Impacting Customers





SolarTAC Entrance

1 MW “Solar2Battery” Project



A world-class facility where solar technology moves from research lab to test site

Site Aerial View
(as of April, 2011)

